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# Practical Operational Readiness Gambits: Operations Training Simulations for the Curiosity Rover

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**This document has been reviewed and determined not to contain  
export controlled technical data.**

# What are PORGs?

## PORGs: Practical Operational Readiness Gambits

- They bridge the gap from classroom-style learning to shadowing the actual uplink operations (also called tactical) for the Mars Science Laboratory (MSL) mission
- PORGs simulate the tactical experience as closely as possible

# PORG History

- The Mars 2020 mission had begun some groundwork in bringing Johnson Space Center style training simulations to their training program
- With the COVID-19 pandemic, there was suddenly a need to train new team members on MSL without having them actively shadowing tactical operations
- The MSL team was able to take that initial groundwork from Mars 2020 and implement the training simulations starting in April 2020

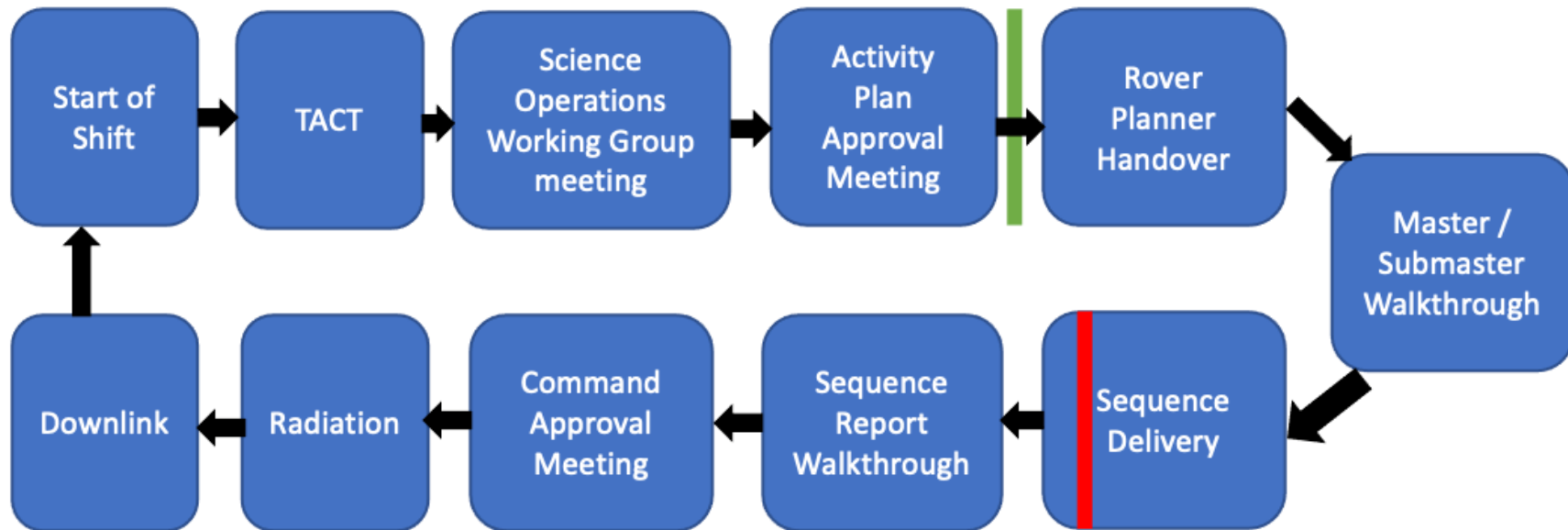
# MSL Training Program to Date

- Most MSL operational roles train “apprenticeship-style”, where you shadow the tactical process for months to years before personnel reach certification
  - Usually there is also some reading, classes, homework, and other types of learning. This varies role to role
- Before the PORGs were implemented, there was no way to teach the dynamic activity planning portion of the tactical process without actually “being in the room”
- For several years there had been significant effort to get a Training GDS venue set up to allow for side-by-side work

# MSL's Tactical Uplink Process

- We don't command in real time, send on average 1-3 sols (Martian days) worth of activities at a time
- We plan on average 3 times a week
- Information is also not received in real time
  - Received back through the Mars orbiters 2-6 times per day
- Note: For more information about MSL's planning process, and in particular adaptation to remote operations during COVID, see the following paper/presentation from this conference: M. Gildner, A. Allbaugh, A. Mishkin, S. Algermissen, M. Kirk, D. Ellison, C. Bridge, T. Stough, A. Stroupe, "Commanding Curiosity from the Couch: MSL Remote Operations, Challenges, and Path Ahead", IEEE Aerospace Conference 2021.

# The Tactical Day



# MSL PORGs

- Over a dozen unique scenarios have been completed so far
  - Each scenario is run twice to make sure all trainees experience the curated scenario
  - We try to cover a variety of common and uncommon scenarios
  - We have increased complexity over time as trainees got more practice and experience
  - We have also been able to practice minor anomaly recovery scenarios
- Started with just the Science Planner and Rover Planner roles
  - Science Planner (SP): build the tactical activity plan and models all activities
  - Rover Planner (RP): responsible for commanding all driving and robotic arm activities
  - Since starting, we have included other tactical roles with trainees



# MSL PORGs

- We take old, completed sols to “re-plan” with the PORG
  - We strive to pick sols that have been identified as particularly interesting or challenging
    - For the Rover Planners, this could be difficult terrain to drive over, uncommon mid-drive imaging, etc.
    - For the Science Planners, this could be activities that require a lot of power or data volume to manage in the activity plan
- Trainees receive the same inputs the actual tactical team had for that plan and follow the uplink process as closely as possible

# Setting Up a PORG

- The PORG designer writes up a “cheat sheet” that mimics the flows and dynamic changes of tactical
  - Also includes information like the working directory, names of targets, imaging sequence information, etc.
- RP trainees get assigned their roles, either to focus on robotic arm activities or drive activities
- SP trainee get a skeleton activity plan
- There is a certified person for each role with trainees to mentor during the PORG, also called PORG herders
  - They “play act” the other operational roles not participating in the PORG
  - The main benefit is they can provide real time feedback and can pause the PORG to spend time training

## Setting Up a PORG

- The PORGs follow the tactical timeline, including moving meeting times if necessary
  - In initial PORGs, this was encouraged to allow a lot more hands-on training time
  - In later PORGs, moving meetings is more discouraged so trainees get used to the timeline pressure of tactical operations

# PORG Difficulty

- The PORG designers and herders have a lot of tactical experience, so they can bring their experience in to easily scale the difficulty with each trainee each PORG
- Some issues are pre-determined by the PORG designer, but some remain opportunistic and the PORG herder can call on these to have the trainee experience a dynamic shift
- The prepared list can includes things like
  - Issues with instrument deliverables
  - Changes in scope or complexity of a plan
  - Communication issues between roles
  - “Death by a thousand cuts” type scenarios
  - Anything really!

# PORGs Work!

- The PORGs shortened the strategic Rover Planner certification time by several months due to the extra practice from PORGs
- RP trainees allowed to participate in remote operations as of August 2020
- RPs also implement a training progress survey for both trainees and certified personnel to provide feedback with
  - Some certified personnel have already identified some trainees ready for certification, several months ahead of where trainees normally would be without PORGs
  - The trainee feedback forms allow them to be honest about what they feel shaky or uncertain about so we can incorporate that into future PORGs



# Lessons Learned

- Weak points in the training program have been identified
  - Gaps have been filled either by adding to classroom sessions, reading, etc.
- Diversify the PORG herders
  - Now have from recently certified personnel to role leads to provide different perspectives
- Even with the Training GDS venue effort to date, significant tool work has still needed to be done
  - RPs have only worked in the Operations Venue due to tool dependencies, but the SPs are on the Training Venue
  - Effort ongoing to make RP tools more Training Venue compatible
- The “cheat sheet” has evolved a lot over time
  - Added actual checklists and word scripts for the usual play-acted roles

# The Future of PORGs

- PORGs will continue, even after the return to on-site operations at JPL
- More tactical roles participating
- Certified personnel practicing rare/anomalous scenarios

# Conclusions

- The PORGs are now an essential part of the MSL training program
- The PORGs have expedited some role certifications
- PORGs allow for trainees to gain valuable hands-on experience

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